자료구조 Homework #10

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```c
#include <stdio.h>
#include <stdlib.h>
```

```c
typedef struct node {
    int key;
    struct node *left;
    struct node *right;
} Node;

/* for stack */
#define MAX_STACK_SIZE      20
Node* stack[MAX_STACK_SIZE];
int top = -1;

Node* pop();
void push(Node* aNode);

/* for queue */
#define MAX_QUEUE_SIZE      20
Node* queue[MAX_QUEUE_SIZE];
int front = -1;
int rear = -1;



int initializeBST(Node** h);
void recursiveInorder(Node* ptr);     /* recursive inorder traversal */
int insert(Node* head, int key);      /* insert a node to the tree */
int freeBST(Node* head); /* free all memories allocated to the tree */

/* functions that you have to implement */
void iterativeInorder(Node* ptr);     /* iterative inorder traversal */
void levelOrder(Node* ptr);           /* level order traversal */
int deleteNode(Node* head, int key);  /* delete the node for the key */
Node* pop();
void push(Node* aNode);
Node* deQueue();
void enQueue(Node* aNode);

/* you may add your own defined functions if necessary */


void printStack();



int main()
{
    char command;
    int key;
    Node* head = NULL;
    printf("------ 2022040014 ---- ohjaesik -------\n");
    do{
        printf("\n\n");
```

```
        printf("----------------------------------------------------------------
\n");
        printf("                   Binary Search Tree #2
\n");
        printf("----------------------------------------------------------------
\n");
        printf(" Initialize BST       = z
\n");
        printf(" Insert Node          = i      Delete Node                  = d
\n");
        printf(" Recursive Inorder    = r      Iterative Inorder (Stack)    = t
\n");
        printf(" Level Order (Queue)  = l      Quit                         = q
\n");
        printf("----------------------------------------------------------------
\n");

        printf("Command = ");
        scanf(" %c", &command);

        switch(command) {
        case 'z': case 'Z':
            initializeBST(&head);
            break;
        case 'q': case 'Q':
            freeBST(head);
            break;
        case 'i': case 'I':
            printf("Your Key = ");
            scanf("%d", &key);
            insert(head, key);
            break;
        case 'd': case 'D':
            printf("Your Key = ");
            scanf("%d", &key);
            deleteNode(head, key);
            break;

        case 'r': case 'R':
            recursiveInorder(head->left);
            break;
        case 't': case 'T':
            iterativeInorder(head->left);
            break;

        case 'l': case 'L':
            levelOrder(head->left);
            break;

        case 'p': case 'P':
```

```
            printStack();
            break;

        default:
            printf("\n       >>>>>   Concentration!!   <<<<<     \n");
            break;
        }

    }while(command != 'q' && command != 'Q');

    return 1;
}

int initializeBST(Node** h) {

    /* if the tree is not empty, then remove all allocated nodes from the tree*/
    if(*h != NULL)
        freeBST(*h);

    /* create a head node */
    *h = (Node*)malloc(sizeof(Node));
    (*h)->left = NULL;  /* root */
    (*h)->right = *h;
    (*h)->key = -9999;

    top = -1;

    front = rear = -1;

    return 1;
}



void recursiveInorder(Node* ptr) //재귀 호출로 inorder 구현
{ //중위순회
    if(ptr) {
        recursiveInorder(ptr->left); //왼쪽으로 이동
        printf(" [%d] ", ptr->key); //왼쪽 리프노드부터 출력됨
        recursiveInorder(ptr->right); // 오른쪽으로 이동
    }
}

/**
 * textbook: p 224
 */
void iterativeInorder(Node* node) //반복문으로 inorder 구현
{
    for(;;) // 무한 반복
```

```
    {
        for(; node; node = node->left) //왼쪽 리프노드에 도달할때까지 stack 에 삽입
            push(node);
        node = pop(); //마지막 노드 pop

        if(!node) break; //노드가 없다면 멈춤
        printf(" [%d] ", node->key); // 현재 노드 값 출력

        node = node->right; //노드의 오른쪽 자식으로 이동
    }
}

/**
 * textbook: p 225
 */
void levelOrder(Node* ptr) //BFS
{
    // int front = rear = -1;

    if(!ptr) return; /* empty tree */

    enQueue(ptr); //queue 에 노드 삽입

    for(;;)
    {
        ptr = deQueue(); //처음 삽입된 노드 추출
        if(ptr) {
            printf(" [%d] ", ptr->key); //노드값 출력

            if(ptr->left) //존재한다면 노드의 왼쪽 자식 queue 에 삽입
                enQueue(ptr->left);
            if(ptr->right)// 존재한다면 노드의 오른쪽 자식 queue 에 삽입
                enQueue(ptr->right);
        }
        else // queue 가 비었다면 반복문 종료
            break;

    }

}


int insert(Node* head, int key)
{
    Node* newNode = (Node*)malloc(sizeof(Node));
    newNode->key = key;
    newNode->left = NULL;
    newNode->right = NULL;
```

```
    if (head->left == NULL) {
        head->left = newNode;
        return 1;
    }

    /* head->left is the root */
    Node* ptr = head->left;

    Node* parentNode = NULL;
    while(ptr != NULL) {

        /* if there is a node for the key, then just return */
        if(ptr->key == key) return 1;

        /* we have to move onto children nodes,
         * keep tracking the parent using parentNode */
        parentNode = ptr;

        /* key comparison, if current node's key is greater than input key
         * then the new node has to be inserted into the right subtree;
         * otherwise the left subtree.
         */
        if(ptr->key < key)
            ptr = ptr->right;
        else
            ptr = ptr->left;
    }

    /* linking the new node to the parent */
    if(parentNode->key > key)
        parentNode->left = newNode;
    else
        parentNode->right = newNode;
    return 1;
}


int deleteNode(Node* head, int key)
{
    if (head == NULL) {
        printf("\n Nothing to delete!!\n");
        return -1;
    }

    if (head->left == NULL) {
        printf("\n Nothing to delete!!\n");
        return -1;
    }

    /* head->left is the root */
```

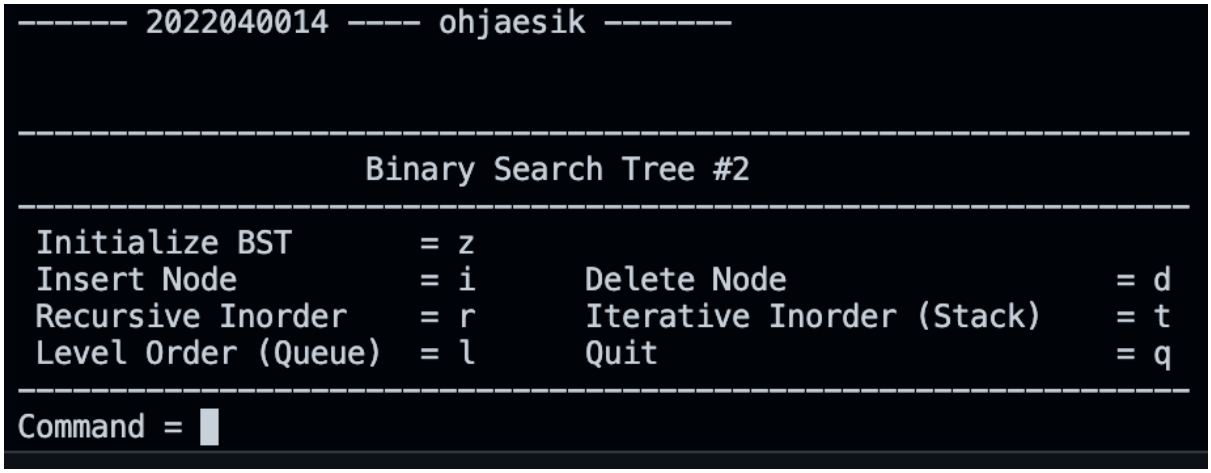
```
    Node* root = head->left;



    Node* parent = NULL;
    Node* ptr = root;

    while((ptr != NULL)&&(ptr->key != key)) {
        if(ptr->key != key) {

            parent = ptr;   /* save the parent */

            if(ptr->key > key)
                ptr = ptr->left;
            else
                ptr = ptr->right;
        }
    }

    /* there is no node for the key */
    if(ptr == NULL)
    {
        printf("No node for key [%d]\n ", key);
        return -1;
    }

    /*
     * case 1: the node which has to be removed is a leaf node
     */
    if(ptr->left == NULL && ptr->right == NULL)
    {
        if(parent != NULL) { /* parent exists, parent's left and right links are
adjusted */
            if(parent->left == ptr)
                parent->left = NULL;
            else
                parent->right = NULL;
        } else {
            /* parent is null, which means the node to be deleted is the root */
            head->left = NULL;

        }

        free(ptr);
        return 1;
    }

    /**
     * case 2: if the node to be deleted has one child
     */
```

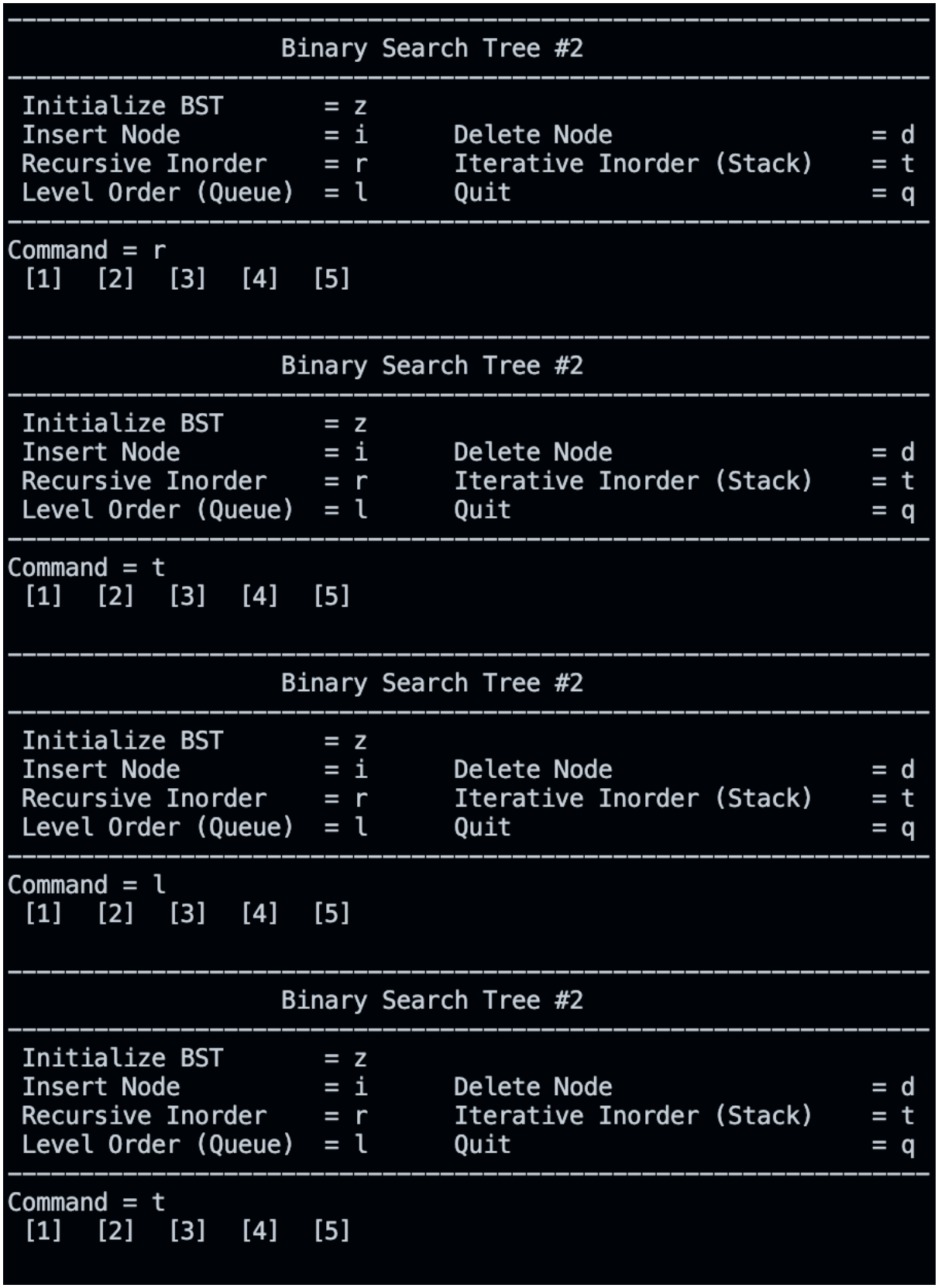
```
    if ((ptr->left == NULL || ptr->right == NULL))
    {
        Node* child;
        if (ptr->left != NULL)
            child = ptr->left;
        else
            child = ptr->right;

        if(parent != NULL)
        {
            if(parent->left == ptr)
                parent->left = child;
            else
                parent->right = child;
        } else {
            /* parent is null, which means the node to be deleted is the root
             * and the root has one child. Therefore, the child should be the root
             */
            root = child;
        }

        free(ptr);
        return 1;
    }

    /**
     * case 3: the node (ptr) has two children
     *
     * we have to find either the biggest descendant node in the left subtree of
the ptr
     * or the smallest descendant in the right subtree of the ptr.
     *
     * we will find the smallest descendant from the right subtree of the ptr.
     *
     */

    Node* candidate;
    parent = ptr;


    candidate = ptr->right;

    /* the smallest node is left deepest node in the right subtree of the ptr */
    while(candidate->left != NULL)
    {
        parent = candidate;
        candidate = candidate->left;
    }

    /* the candidate node is the right node which has to be deleted.
```

```
     * note that candidate's left is null
     */
    if (parent->right == candidate)
        parent->right = candidate->right;
    else
        parent->left = candidate->right;

    /* instead of removing ptr, we just change the key of ptr
     * with the key of candidate node and remove the candidate node
     */

    ptr->key = candidate->key;

    free(candidate);
    return 1;
}


void freeNode(Node* ptr)
{
    if(ptr) {
        freeNode(ptr->left);
        freeNode(ptr->right);
        free(ptr);
    }
}

int freeBST(Node* head)
{

    if(head->left == head)
    {
        free(head);
        return 1;
    }

    Node* p = head->left;

    freeNode(p);

    free(head);
    return 1;
}



Node* pop() //stack 의 top 값 추출.
{
    if (top < 0) return NULL; //top 이 0 보다 작을때
    return stack[top--];
```

```
}

void push(Node* aNode) // stack 의 top 에 삽입
{
    stack[++top] = aNode;
}


void printStack()
{
    int i = 0;
    printf("--- stack ---\n");
    while(i <= top)
    {
        printf("stack[%d] = %d\n", i, stack[i]->key);
    }
}


Node* deQueue() //stack 의 front 값 추출
{
    if (front == rear) {
        // printf("\n....Now Queue is empty!!\n" );
        return NULL;
    }

    front = (front + 1) % MAX_QUEUE_SIZE;
    return queue[front];

}

void enQueue(Node* aNode) // queue 에 rear 에 값 삽입
{
    rear = (rear + 1) % MAX_QUEUE_SIZE;
    if (front == rear) {
        // printf("\n....Now Queue is full!!\n");
        return;
    }

    queue[rear] = aNode;
}
```

```
Total 140 (delta 45), reused 0 (delta 0), pack-reused 0
remote: Resolving deltas: 100% (45/45), done.
To https://github.com/ohjaesik/homework10
 * [new branch]      main -> main
➜  자료구조 git:(main) ✗ git rm -catch binary-search-tree.c
error: unknown switch `c'
usage: git rm [-f | --force] [-n] [-r] [--cached] [--ignore-unmatch]
              [--quiet] [--pathspec-from-file=<file> [--pathspec-file-nul]]
              [--] [<pathspec>...]

    -n, --dry-run         dry run
    -q, --quiet           do not list removed files
    --cached              only remove from the index
    -f, --force           override the up-to-date check
    -r                    allow recursive removal
    --ignore-unmatch      exit with a zero status even if nothing matched
    --sparse              allow updating entries outside of the sparse-checkout
cone
    --pathspec-from-file <file>
                          read pathspec from file
    --pathspec-file-nul   with --pathspec-from-file, pathspec elements are separ
ated with NUL character

➜  자료구조 git:(main) ✗ git git rm -cached  binary-search-tree.c
error: did you mean `--cached` (with two dashes)?
➜  자료구조 git:(main) ✗ git rm --cached  binary-search-tree.c
rm 'binary-search-tree.c'
➜  자료구조 git:(main) ✗ git commit -m '삭제'
[main 7fffd77] 삭제
 Committer: 오재식 <ojaesig@ojaesigs-MacBook-Air.local>
Your name and email address were configured automatically based
on your username and hostname. Please check that they are accurate.
You can suppress this message by setting them explicitly. Run the
following command and follow the instructions in your editor to edit
your configuration file:

    git config --global --edit

After doing this, you may fix the identity used for this commit with:

    git commit --amend --reset-author

 1 file changed, 322 deletions(-)
 delete mode 100644 binary-search-tree.c
➜  자료구조 git:(main) ✗ git push origin main
Enumerating objects: 3, done.
Counting objects: 100% (3/3), done.
Delta compression using up to 8 threads
Compressing objects: 100% (1/1), done.
Writing objects: 100% (2/2), 252 bytes | 252.00 KiB/s, done.
Total 2 (delta 0), reused 0 (delta 0), pack-reused 0
To https://github.com/ohjaesik/homework10
   380245d..7fffd77  main -> main
➜  자료구조 git:(main) ✗
```


------ 2022040014 ---- ohjaesik -------
Binary Search Tree #2
Initialize BST = z
Insert Node = i
Delete Node = d
Recursive Inorder = r
Iterative Inorder (Stack) = t
Level Order (Queue) = l
Quit = q
Command =



https://github.com/ohjaesik/homework10